Module 2 - Exercises

Problem 1 (from old intermediate test)

Find the corresponding reflection coefficients of the following normalised impedances and admittances in the Smith Chart:

(a) $\frac{Z_1}{Z_0} = 0.4 + j0.30$

(b) $\frac{Z_2}{Z_0} = -j0.50$

(c) $\frac{Y_3}{Y_0} = 0.4 - j0.2$

(d) $\frac{Y_4}{Y_0} = \infty$

Problem 2 (a-d from old intermediate test)

(a) Consider the setup shown in Figure 1. In the Smith Chart, find the reflection coefficient Γ_{Load} of the load impedance $Z_L = 10 - j20\Omega$ with respect to the characteristic impedance of the transmission line, $Z_0 = 50\Omega$.

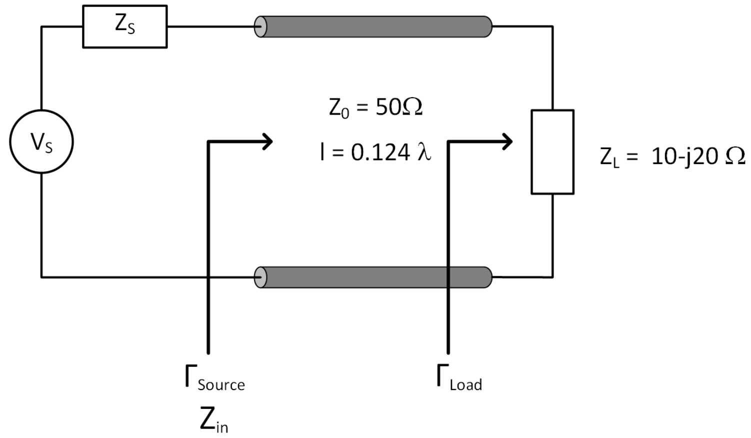

Figure 1 Transmission line setup for Problem 2.

(b) Determine the input reflection coefficient Γ_{in} of the terminated transmission line from Figure 1 with respect to the generator ($Z_S = 50\Omega$) from the Smith Chart.

(c) Determine the input impedance Z_{in} seen from the source, as shown in Figure 1.

(d) Explain how you would match this using a single lumped element. State explicitly what type of lumped element you use, whether you put it parallel or in series, and how you would find its value in ohms using the Smith chart.

(e) Now, repeat part (d) for a distributed element.

Problem 3: Transmission lines and microwave networks (old exam question)

A load impedance $Z_L = (15 + j39)\Omega$ is connected to a transmission line network as shown in Figure 1. The network consists of two transmission lines, one with characteristic impedance $Z_0 = 75\Omega$ and length $l_0 = 0.5$m and the other one with characteristic impedance $Z_1 = 150\Omega$ and length $l_1 = 0.321m$. In between the two transmission lines there is a matching network consisting of impedances Z_p and Z_s. The whole setup is driven by a generator with internal impedance $Z_0 = 75\Omega$ at an operating-frequency of 400 MHz.

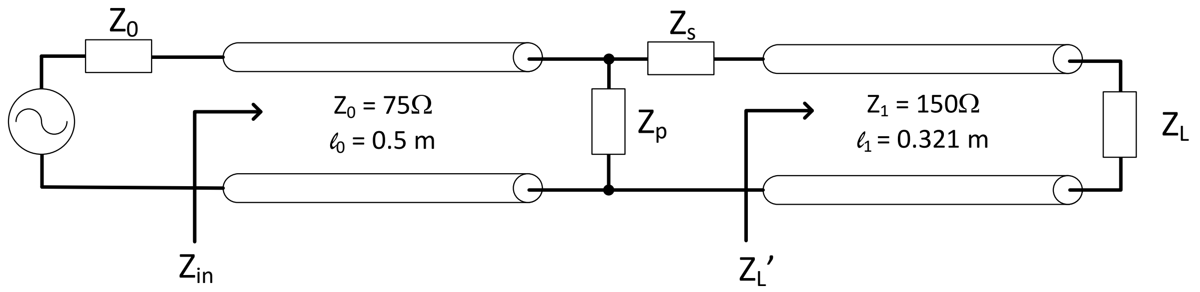

Figure 2: Setup for Question 1a)-d).

a) Determine the magnitude and phase of the reflection coefficient of Z_L with respect to the characteristic impedance $Z_1 = 150\Omega$.

b) Use the Smith Chart to determine the equivalent impedance Z_L' at the beginning of the transmission line with characteristic impedance Z_1. Make clear how you get to your answer (clear markings in the Smith Chart or a written explanation).

c) Use your solution from b) and the Smith chart to determine the values for Z_p and Z_s of the matching network, such that the maximum power is delivered from the generator to the load impedance Z_L. Make clear how you get to your answer (clear markings in the Smith Chart or a written explanation).

Consider now the setup shown in Figure 3.

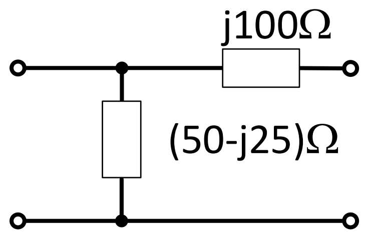

Figure 3: Setup for e)-f).

d) Determine the S-matrix, [S], of the setup shown in Figure 3.

e) Is the scattering matrix of the setup shown in Figure 3 unitary ($[S]^t[S]^* = [U]$)? Explain your answer.